



THE UNIVERSITY *of* EDINBURGH

## Edinburgh Research Explorer

### Influence of maternal and paternal IQ on offspring health and health behaviours

**Citation for published version:**

Whitley, E, Gale, CR, Deary, IJ, Kivimaki, M, Singh-Manoux, A & Batty, GD 2013, 'Influence of maternal and paternal IQ on offspring health and health behaviours: Evidence for some trans-generational associations using the 1958 British birth cohort study', *European Psychiatry*, vol. 28, no. 4, pp. 219-224.  
<https://doi.org/10.1016/j.eurpsy.2012.01.005>

**Digital Object Identifier (DOI):**

[10.1016/j.eurpsy.2012.01.005](https://doi.org/10.1016/j.eurpsy.2012.01.005)

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Early version, also known as pre-print

**Published In:**

European Psychiatry

**Publisher Rights Statement:**

This is an Author's Accepted Manuscript of the following article: © Whitley, E., Gale, C. R., Deary, I. J., Kivimaki, M., Singh-Manoux, A. & Batty, G. D. 2013, "Influence of maternal and paternal IQ on offspring health and health behaviours: Evidence for some trans-generational associations using the 1958 British birth cohort study", in *European psychiatry : the journal of the Association of European Psychiatrists*. The final publication is available at <http://www.sciencedirect.com/science/journal/09249338>

**General rights**

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

**Take down policy**

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact [openaccess@ed.ac.uk](mailto:openaccess@ed.ac.uk) providing details, and we will remove access to the work immediately and investigate your claim.



**Influence of maternal and paternal IQ on offspring health and health behaviours: evidence for some trans-generational effects using the 1958 British birth cohort study**

Elise Whitley<sup>1</sup>, Catharine R. Gale<sup>2,3</sup>, Ian J. Deary<sup>3</sup>, Mika Kivimaki<sup>1</sup>, Archana Singh-Manoux<sup>1</sup>, G. David Batty<sup>1,3</sup>

<sup>1</sup>Department of Epidemiology and Public Health, University College London, London, UK.

<sup>2</sup>Medical Research Council Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK

<sup>3</sup>Centre for Cognitive Ageing and Cognitive Epidemiology, Department of Psychology, University of Edinburgh, Edinburgh, UK

**Author for correspondence:**

G. David Batty, Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, London WC1E 6BT

Tel: +44 (0)20 7679 1680, Fax: +44 (0)20 7813 0242, Email: David.Batty@ucl.ac.uk

**Key words:** Intelligence, Life course, Birth cohort, Trans-generational

**Word count:** 2,604

## **Abstract**

**Purpose:** Individuals scoring poorly on tests of intelligence (IQ) have been reported as having increased risk of morbidity, premature mortality, and risk factors such as obesity, high blood pressure, poor diet, alcohol and cigarette consumption. Very little is known about the impact of parental IQ on the health and health behaviours of their offspring.

**Methods:** We explored associations of maternal and paternal IQ scores with offspring television viewing, injuries, hospitalisations, long standing illness, height and BMI at ages 4 to 18 using data from the National Child Development Study (1958 birth cohort).

**Results:** Data were available for 1,446 mother-offspring and 822 father-offspring pairs. After adjusting for potential confounding/mediating factors, the children of higher IQ parents were less likely to watch TV (odds ratio (95% confidence interval) for watching 3+ vs. <3 hours per week associated with a standard deviation increase in maternal or paternal IQ: 0.75 (0.64, 0.88) or 0.78 (0.64, 0.95) respectively) and less likely to have one or more injuries requiring hospitalisation (0.77 (0.66, 0.90) or 0.72 (0.56, 0.91) respectively for maternal or paternal IQ).

**Conclusions:** Children whose parents have low IQ scores may have poorer selected health and health behaviours. Health education might usefully be targeted at these families.

**Word count:** 202

## **INTRODUCTION**

There is an growing body of evidence to suggest that low scores on tests of intelligence (IQ), measured using standard picture, oral or written tests(13), in pre- and early-adulthood are associated with an increase in mortality and morbidity from a range of causes several decades later(2, 20-21, 23-24, 35). A series of studies have also shown that low IQ is associated with a range of established risk factors for premature mortality including obesity(10), raised blood pressure(31), alcohol use(3), cigarette smoking(6), physical inactivity(5), poor diet(5), and injuries(36). In contrast to the range of data available on own IQ, very little is known about the impact, if any, of parental IQ on the health and health behaviours of their offspring. It is of particular interest to consider the impact of parental IQ on offspring health in childhood as this is the period when parents are likely to have the greatest influence on the lifestyle of their children.

A small number of studies from resource-poor countries have reported associations of lower maternal IQ with greater offspring morbidity(8) and mortality(11, 30). In keeping with these observations, the offspring of lower IQ women have been found to have poorer nutrition(9, 17, 32-33), and are more likely to be malnourished(1) or to have stunted growth(30, 34). Although of interest, the majority of these results are restricted to very specific, resource-poor communities and tend to be based on relatively small numbers, limiting their generalisability to western populations. Studies of maternal IQ in affluent countries have largely focussed on infant feeding practices and women with higher IQ scores have been observed to be more likely to breastfeed(14, 18, 22, 26) and to breastfeed for longer(18). In one small study of families in Scotland(19), parental IQ was assessed at around 11 years of age and the (adult) offspring of

those with higher IQ scores were found to be taller, to have higher educational and socioeconomic status (SES), and to smoke fewer cigarettes.

In addition to the problem of generalisability, a number of other shortcomings are evident. First, and perhaps most crucially, previous studies have not explored the role of offspring IQ, which, in addition to being associated with parental IQ, may have a separate influence on health behaviours(3, 5-6, 10, 31, 36). Second, only a handful of previous studies have examined the specific impact of fathers' IQ on offspring health and behaviours(18-19, 34). Although maternal and paternal IQ scores are likely to be correlated, having IQ measurements in both mothers and fathers allows comparison of each with offspring health behaviours. This is of value because similar effects of maternal and paternal IQ would suggest that associations are generated by factors that are just as likely to be transmitted from father to offspring as they are from mother to offspring, for example nuclear genetic variation, socioeconomic position, or shared lifestyle factors. In contrast, a stronger maternal IQ–offspring health gradient would implicate maternal characteristics, such as the impact of intrauterine milieu or the greater influence of maternal input in child rearing.

The present study examines associations between parental IQ and offspring health and behaviours in the 1958 National Child Development Study. The size of the sample, along with IQ data on mothers, fathers and offspring have allowed us to address many of the shortcomings of previous studies in this area.

## **METHODS**

### **Study population and measurements**

The National Child Development Study(29) (1958 cohort) comprises over 17,000 live births in Great Britain occurring between 3<sup>rd</sup> and 9<sup>th</sup> March 1958. Follow-up sweeps were carried out in 1965, 1969, 1974, 1991 and 1999-2000. The 1991 follow-up collected data on the original cohort, then aged 33, and also from the offspring of one in three randomly selected cohort members. The cohort member's mental ability was assessed at school in 1969, aged 11, using a general ability test devised by the National Foundation for Educational Research (NFER) in England and Wales(15). Scores from this test correlate strongly with verbal ability test scores used to select 11-year-olds for secondary school(15), suggesting high concurrent validity. Data on marital status and SES were collected in 1991. SES was based on own occupation for male cohort members and husband's occupation for female cohort members, and was grouped in five categories: I (Professional), II (Managerial and technical/intermediate), III (Skilled (non-manual/manual)), IV (Partly skilled), V (Unskilled)).

Offspring IQ tests were administered by interviewers in 1991 and include the Peabody Picture Vocabulary Test (PPVT), the McCarthy Scale of Child Abilities (verbal subscale) and the Wechsler Intelligence Scale for Children (digit span subscale). PPVT scores were measured in all children aged 4 and over and we present results based on these data here. Results based on other IQ measures, which were available for smaller subgroups of children (McCarthy Scale: children aged 4-6 years; Wechsler Scale: children aged 7+ years), were broadly similar (results

available on request). PPVT is a widely used and recognised indicator of children's cognitive function and correlates well with other IQ-type measures(16).

Information on offspring health and behaviours were collected during interviews with the cohort member: television viewing habits (used as a proxy for sedentary behaviour: hours per average weekday, coded <3 vs. 3+), injuries (requiring medical attention: coded <2 vs. 2+; requiring hospitalisation: coded 0 vs. 1+), and illness (child admitted to hospital (excluding injuries): coded 0 vs. 1+; child has long-standing illness, disability or infirmity). In addition, interviewers measured offspring height and weight. Although largely under genetic control, short stature is known to be influenced by a number of early-life factors including lower SES, lower income, greater household overcrowding and poor nutrition(37) and is an increasingly widely used proxy measure of childhood circumstances. We calculated body mass index (BMI) as  $(\text{weight (kg)}) / (\text{height (m)})^2$ . Height and weight analysed as age- and sex-standardised z-scores.

## **Statistical analyses**

Parental IQ associations with offspring health and behaviours were based on cohort member-offspring pairs where the offspring were non-adopted and aged 4 to 18 years at the time of data collection. Analyses were carried out separately for mother- vs. father-offspring pairs in order to explore potential differences in associations with maternal vs. paternal IQ. Corresponding statistical tests for interaction/effect modification were performed. Analyses were carried out using logistic regression or least squares regression for binary or continuous outcomes respectively. Associations are presented as odds ratios (OR) or mean change in outcome per standard deviation (SD) increase in parental IQ. Preliminary analyses were also carried out based

on quintiles of parental IQ to confirm that associations were approximately linear (results not shown). Confidence intervals (CI) are based on robust standard errors which take account of the possible non-independence of children from the same family. All analyses are adjusted for offspring age and sex with additional adjustments for SES and offspring IQ. Parental IQ associations with offspring height are also adjusted for parental height which is known to be associated with both offspring height and own IQ(12). Analyses are based on parent-offspring pairs with complete data on parental IQ, the outcome of interest, and all confounding variables.

There is some evidence from previous studies that maternal age at birth may have a confounding/mediating effect on maternal IQ-child health associations as lower IQ women may be more likely to have their children at younger ages(27). It is therefore of interest to consider the impact of adjusting parental IQ-child health associations for parental age. In the present analysis cohort members were born in the same week and data on offspring were collected over a short period of time in 1991. Adjustment for offspring age at interview in these data is therefore equivalent to adjusting for parental age at birth. We have confirmed that additional adjustment for parental age had no impact on the results presented here (results available on request). Finally, we examined the cohort member's marital status in 1991 but, as the overwhelming majority of women (98.9%) and men (98.8%) reported that they were married, there was no impact on the results presented here.

## **RESULTS**



The original sample consisted of 4,287 parent-offspring pairs (Figure 1). A total of 133 (3.1%) children were adopted or their relationship to the cohort member was unknown, and a further 1,170 (27.3%) children were aged <4 years in 1991 (when offspring IQ measurements were made). Of the remaining 2,984 non-adopted parent-offspring pairs, parental IQ was unavailable for 379 (12.7%) and there were missing data on covariates for 337 (11.3%), leaving a total of 2,268 pairs in the analytical sample of which 1,446 (63.8%) were mother-offspring pairs and 822 (36.2%) were father-offspring pairs. The characteristics of these parent-offspring pairs are shown in Table 1. Just under 50% of offspring were male and this, along with average offspring IQ, was very similar in mother- vs. father-offspring pairs. Almost two thirds of cohort members were from SES III, although fathers were slightly more likely to be from SES I or II, in spite of a slightly lower average IQ than mothers at age 11. The main difference between mother- and father-offspring pairs was the average offspring age in 1991 which was 1.3 years lower in father-offspring pairs, perhaps reflecting a tendency towards later parenthood in men.

The characteristics of those excluded from the analyses as a result of missing data were generally similar to those included in our sample. The exception to this was that parental IQ and SES was higher in parent-offspring pairs excluded specifically because the child was aged <4 years in 1991. This would be consistent with a tendency toward later parenthood in higher IQ cohort members. A similar pattern of later parenthood (corresponding to younger children in 1991) in those with higher IQ scores was also apparent in parent-offspring pairs included in the analyses (Table 2) with a SD increase in parental IQ associated with a 0.72 (0.56, 0.88) or 0.52 (0.35, 0.70) year decrease in average offspring age in 1991 for mothers and fathers respectively. These results reinforce the importance of adjusting analyses for parental age at birth, in this case

equivalent to offspring age in 1991. Offspring IQ was correlated ( $p < 0.001$ ) with both maternal (correlation coefficient: 0.27) and paternal (0.28) IQ.

Associations between parental IQ and offspring health and behaviours are shown in Table 3. All analyses are adjusted for offspring sex and age. Additional separate adjustments for parental SES and offspring IQ had little impact (available on request) and we present models adjusted for all factors simultaneously for simplicity. Children whose parents had higher IQ scores at age 11 were increasingly less likely to watch 3+ hours of TV on a typical weekday or to have had 1 or more injury requiring hospitalisation, and ORs based on maternal vs. paternal IQ scores were very similar. In contrast, whereas a SD increase in paternal IQ was associated with a 18% (1%, 31%) reduction in the risk of 2 or more injuries requiring medical treatment in the child, there was no evidence of a similar association with maternal IQ ( $p$  for interaction: 0.03). In age/sex adjusted models, increasing parental IQ was only weakly associated with increasing offspring height and, in models that also adjusted for parental height, there was no parental IQ-offspring height association. There was no evidence of parental IQ associations with offspring long-standing illness, disability or infirmity, general hospital admissions (excluding injuries), or BMI.

## **DISCUSSION**

The aim of this study was to explore parental IQ associations with a number of aspects of offspring health and behaviours. We have carried out relatively large number of comparisons and have therefore focussed on strength and consistency of associations rather than on the results of individual significance tests. After adjustment for offspring age, sex, IQ, and parental SES, the

children of higher IQ parents were less likely to watch TV and less likely to have had an injury requiring hospitalisation. Associations with maternal vs. paternal IQ were generally very similar with the possible exception of a lower risk of injury requiring medical attention with increasing *paternal* IQ only.

The current analyses have a number of advantages over previous studies. Our sample size was relatively large in this context, providing good statistical power, and the original cohort from which our sample was drawn is representative of all women and men born in Britain at around this time. We had data on parental IQ measured in childhood, before any substantial impact of education on performance on IQ tests and, uniquely to our knowledge, we also have data on offspring IQ.

There are also some limitations to our analyses. Only a third of cohort members with children were included in the follow-up survey. It is reassuring, however, that their mean IQ was generally almost identical to those included in the analyses and we have no reason to believe that this exclusion will have biased our results.. Offspring data were collected when they were aged 4 to 18, which could have resulted in artefactual associations given the relationship between maternal IQ and age at birth. We were therefore careful to adjust all analyses for offspring age (and sex) and, in addition, used age-standardised z-scores for BMI and height. Although we also looked at the impact of other adjustments, we cannot rule out residual confounding by other unmeasured confounding/mediating factors that might have influenced our results and, in particular, our single measure of SES may not have captured all the influences involved. Finally, it is possible that reporting bias may have influenced the analyses of more subjective outcomes,

e.g. TV viewing habits, if higher IQ parents were more likely to give favourable responses, resulting in a slight overestimate of effects.

The offspring of higher IQ parents were less likely to watch 3+ hours of TV on a typical weekday, suggesting a more sedentary lifestyle. We were unable to explore the impact of parental IQ on offspring sedentary lifestyle directly as no exercise data were available. It is of note, however, that there was no evidence of any association between parental IQ and offspring BMI. There was also a strong association of increasing injuries requiring hospitalisation with lower maternal and paternal IQ and a weaker association of increasing injuries requiring medical treatment with paternal IQ only. There is a growing literature which suggests that individuals with lower IQ scores have higher rates of unintentional injury(4, 7, 21, 25, 28, 36) and a number of explanations have been mooted. These include the observation that lower IQ individuals tend to have lower SES and may therefore live and work in more hazardous environments or, alternatively, that low IQ is associated with a lower perception of risk leading to an increased likelihood of risk-taking behaviors. The associations observed in the current analyses remained after adjustment for SES, suggesting that the practical consequences of low parental IQ, e.g. low SES or poor housing conditions, do not explain them. Similarly, adjustment for child's own IQ had no impact, which indicates that the associations are not simply a result of children with lower inherited IQ scores taking additional risks. Rather, it is possible that parents with lower IQ scores have a reduced perception of risk, not only for themselves, but also for their children, and may therefore be less likely to discourage risky behaviours. Rather more speculatively, the isolated association of injuries requiring medical treatment in the offspring of low IQ fathers

might support a more physical role of parenting in men although, equally, it may suggest that mothers are more likely to seek medical help, or may simply be a chance finding.

## **CONCLUSION**

Our analyses suggest that parental IQ is associated with some aspects of offspring health and behaviours independent of SES and child's own IQ. Education regarding healthy behaviours and, in particular, injury risk may usefully be targeted at parents with lower IQ scores.

**Funding:** DB is a Wellcome Trust Fellow, funding from which also supports EW. The Centre for Cognitive Ageing and Cognitive Epidemiology is supported by the Biotechnology and Biological Sciences Research Council, the Engineering and Physical Sciences Research Council, the Economic and Social Research Council, the MRC, and the University of Edinburgh as part of the cross-council Lifelong Health and Wellbeing initiative. MK is supported by the Academy of Finland, the BUPA Foundation, UK, and the NIH/National Heart, Lung, and Blood Institute (R01HL036310-20A2) and the National Institute on Aging (R01AG034454), US.

**Conflict of interest:** The authors have not transmitted any conflicts of interest.

**Authors' contributions:** All authors contributed to the design and interpretation of the study, critically revised the manuscript, and approved the final version. EW conducted the statistical analyses and, with DB, wrote the first draft. EW had full access to all the data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis. EW is the guarantor.

1. Anoop S, Saravanan B, Joseph A, Cherian A, Jacob KS. Maternal depression and low maternal intelligence as risk factors for malnutrition in children: a community based case-control study from South India. *Arch Dis Child* 2004;89:325-9.
2. Batty GD, Deary IJ, Gottfredson LS. Premorbid (early life) IQ and later mortality risk: systematic review. *Ann Epidemiol* 2007;17:278-88.
3. Batty GD, Deary IJ, Schoon I, Emslie C, Hunt K, Gale CR. Childhood mental ability and adult alcohol intake and alcohol problems: the 1970 British cohort study. *Am J Public Health* 2008;98:2237-43.
4. Batty GD, Deary IJ, Schoon I, Gale CR. Childhood mental ability in relation to cause-specific accidents in adulthood: the 1970 British Cohort Study. *QJM* 2007;100:405-14.
5. Batty GD, Deary IJ, Schoon I, Gale CR. Childhood mental ability in relation to food intake and physical activity in adulthood: the 1970 British Cohort Study. *Pediatrics* 2007;119:e38-45.
6. Batty GD, Deary IJ, Schoon I, Gale CR. Mental ability across childhood in relation to risk factors for premature mortality in adult life: the 1970 British Cohort Study. *J Epidemiol Community Health* 61: 2007;997-1003.
7. Batty GD, Gale CR, Tynelius P, Deary IJ, Rasmussen F. IQ in early adulthood, socioeconomic position, and unintentional injury mortality by middle age: a cohort study of more than 1 million Swedish men. *Am J Epidemiol* 2009;169:606-15.
8. Bhargava A. Modeling the effects of nutritional and socioeconomic factors on the growth and morbidity of Kenyan school children. *Am J Hum Biol* 1999;11:317-26.
9. Bhargava A, Fox-Kean M. The effects of maternal education versus cognitive test scores on child nutrition in Kenya. *Econ Hum Biol* 2003;1:309-19.

10. Chandola T, Deary IJ, Blane D, Batty GD. Childhood IQ in relation to obesity and weight gain in adult life: the National Child Development (1958) Study. *Int J Obes (Lond)* 2006;30:1422-32.
11. Cvorovic J, Rushton JP, Tenjevic L. Maternal IQ and child mortality in 222 Serbian Roma (Gypsy) women. *Pers Individ Diff* 2008;44:1604-9.
12. Davey Smith G, Hart CL, Hole DJ, MacKinnon P, Gillis C, Watt G, et al. Education and occupational social class: which is the more important indicator of mortality risk? *J Epidemiol Community Health* 1998;52:153-60.
13. Deary IJ, Batty GD. Cognitive epidemiology. *J Epidemiol Community Health* 2007;61:378-84.
14. Der G, Batty GD, Deary IJ. Effect of breast feeding on intelligence in children: prospective study, sibling pairs analysis, and meta-analysis. *BMJ* 2006;333:945-50.
15. Douglas J. The home and the school: a study of ability and attainment in primary school. London: MacGibbon and Kee, 1964.
16. Dunn L, Dunn L. Peabody Picture Vocabulary Test-Revised. Circle Pines, MN: American Guidance Service, 1981.
17. Gale CR, Martyn CN, Marriott LD, Limond J, Crozier S, Inskip HM, et al. Dietary patterns in infancy and cognitive and neuropsychological function in childhood. *J Child Psychol Psychiatry* 2009;50:816-23.
18. Gomez-Sanchiz M, Canete R, Rodero I, Baeza JE, Gonzalez JA. Influence of breast-feeding and parental intelligence on cognitive development in the 24-month-old child. *Clin Pediatr* 2004;43:753-61.



19. Hart CL, Deary IJ, Davey Smith G, Upton MN, Whalley LJ, Starr JM, et al. Childhood IQ of parents related to characteristics of their offspring: linking the Scottish Mental Health Survey 1932 to the Midspan Family Study. *J Biosoc Sci* 2005;37:623-39.
20. Hart CL, Taylor MD, Davey Smith G, Whalley LJ, Starr JM, Hole DJ, et al. Childhood IQ, social class, deprivation and their relationships with mortality and morbidity risk in later life: prospective observational study linking the Scottish Mental Survey 1932 and the Midspan studies. *Psychosom Med* 2003;65:877-83.
21. Hemmingsson T, Melin B, Allebeck P, Lundberg I. The association between cognitive ability measured at ages 18-20 and mortality during 30 years of follow-up - a prospective observational study among Swedish males born 1949-51. *Int J Epidemiol* 2006;35:665-70.
22. Jacobson SW, Jacobson JL, Frye KF. Incidence and Correlates of Breast-feeding in Socioeconomically Disadvantaged Women. *Pediatrics* 1991;88:728-36, 1991.
23. Jokela M, Batty GD, Deary IJ, Gale CR, Kivimaki M. Low Childhood IQ and Early Adult Mortality: The Role of Explanatory Factors in the 1958 British Birth Cohort. *Pediatrics* 2009;124:e380-8.
24. Jokela M, Elovainio M, Singh-Manoux A, Kivimaki M. IQ, socioeconomic status, and early death: The US National Longitudinal Survey of Youth. *Psychosom Med* 2009;71:322-8.
25. Lawlor DA, Clark H, Leon DA. Associations between childhood intelligence and hospital admissions for unintentional injuries in adulthood: the Aberdeen Children of the 1950s cohort study. *Am J Public Health* 2007;97:291-7.
26. Morrow-Tlucak M, Haude RH, Ernhart CB. Breastfeeding and cognitive development in the first 2 years of life. *Soc Sci Med* 1988;26:635-9.

27. Neiss M, Rowe DC, Rodgers JL. Does education mediate the relationship between IQ and age at first birth? A behavioural genetic analysis. *J Biosoc Sci* 2002;34:259-75.
28. Osler M, Andersen AM, Laursen B, Lawlor DA. Cognitive function in childhood and early adulthood and injuries later in life: the Metropolit 1953 male birth cohort. *Int J Epidemiol* 2007;36:212-9.
29. Power C, Elliott J. Cohort profile: 1958 British birth cohort (National Child Development Study). *Int J Epidemiol* 2006;35:34-41.
30. Sandiford P, Cassel J, Sanchez G, Coldham C. Does intelligence account for the link between maternal literacy and child survival? *Soc Sci Med* 1997;45:1231-9.
31. Starr JM, Taylor MD, Hart CL, Davey Smith G, Whalley LJ, Hole DJ, et al. Childhood mental ability and blood pressure at midlife: linking the Scottish Mental Survey 1932 and the Midspan studies. *J Hypertens* 2004;22:893-7.
32. Wachs TD, Creed-Kanashiro H, Cueto S, Jacoby E. Maternal education and intelligence predict offspring diet and nutritional status. *J Nutr* 2005;135:2179-86.
33. Wachs TD, McCabe G. Relation of maternal intelligence and schooling to offspring nutritional intake. *Int J Behavioral Development* 2001;25:444-9.
34. Webb KE, Horton NJ, Katz DL. Parental IQ and cognitive development of malnourished Indonesian children. *Eur J Clin Nutr* 2005;59:618-20.
35. Whalley LJ, Deary IJ. Longitudinal cohort study of childhood IQ and survival up to age 76. *BMJ* 2001;322:823-7.
36. Whitley E, Batty GD, Gale CR, Deary IJ, Tynelius P, Rasmussen F. Intelligence in early adulthood and subsequent risk of unintentional injury over two decades: cohort study of 1 109 475 Swedish men. *J Epidemiol Community Health* 2010;64:419-25.

37. Whitley E, Gunnell D, Davey Smith G, Holly JM, Martin RM. Childhood circumstances and anthropometry: the Boyd Orr cohort. *Ann Hum Biol* 2008;35:518-34.

Figure 1: Selection of analytical sample

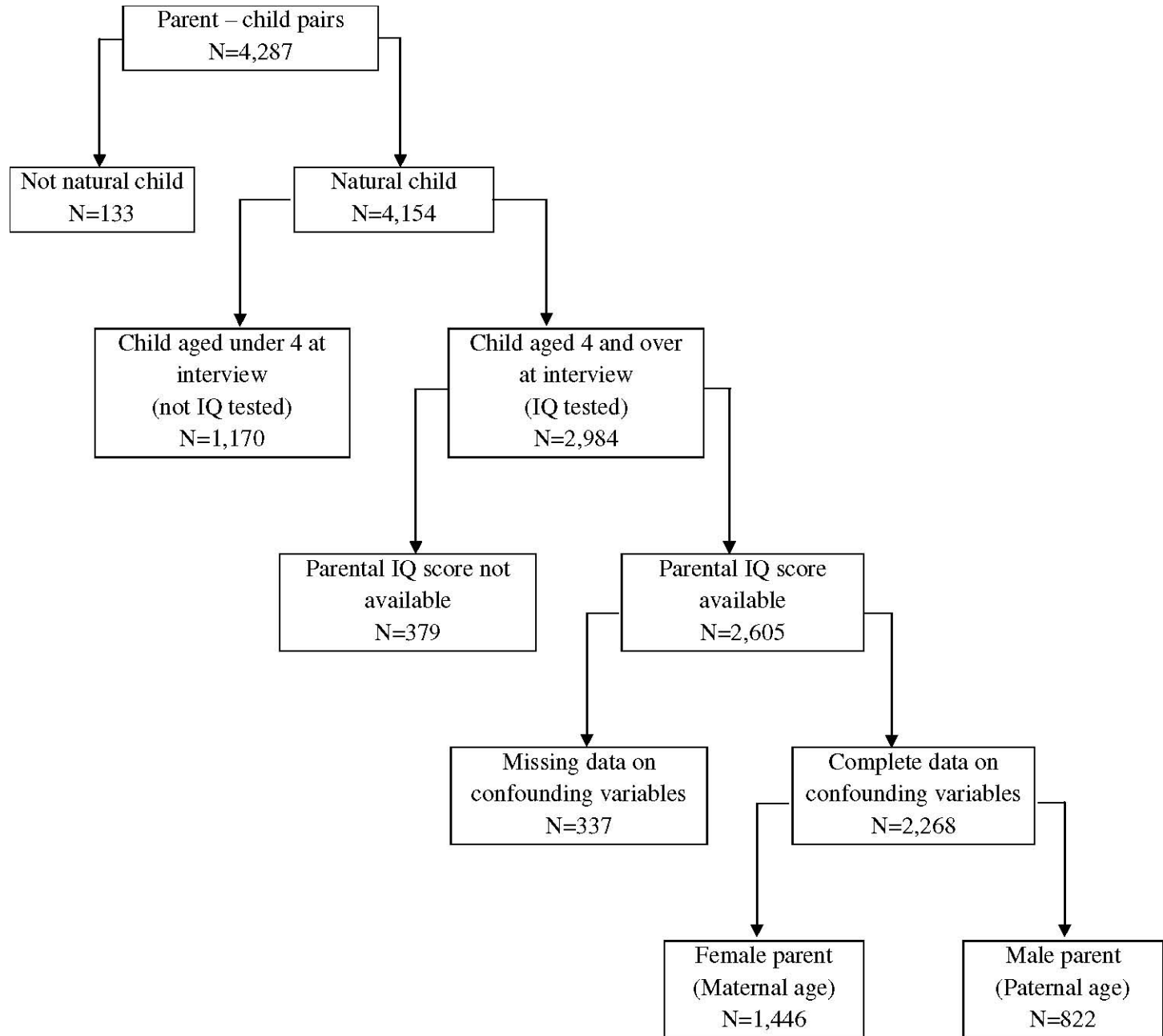


Table 1: Characteristics of 2,268 parent-offspring pairs

	Mother-offspring pairs (N=1,446)	Father-offspring pairs (N=822)
Offspring sex (N (%))		
Male	712 (49.2)	399 (48.5)
Female	734 (50.8)	423 (51.5)
Socioeconomic status (N (%))		
I (Professional)	43 ( 3.0)	34 ( 4.1)
II (Managerial and technical/intermediate)	102 ( 7.1)	98 (11.9)
III (Skilled (non-manual/manual))	948 (65.6)	491 (59.7)
IV (Partly skilled)	194 (13.4)	109 (13.3)
V (Unskilled)	159 (11.0)	90 (11.0)
Offspring age in 1991 (Mean (SD))	8.6 (3.2)	7.3 (2.6)
Offspring IQ (PPVT) score in 1991 (Mean (SD))	34.3 (11.1)	33.7 (10.6)
Parental IQ (NEFR) score at age 11 (Mean (SD))	43.3 (15.4)	41.8 (15.4)

Table 2: Mean (SD) offspring age in 1991 by quintiles of parental IQ at age 11

Parental IQ quintiles	Mother-offspring pairs (N=1,446)	Father-offspring pairs (N=822)
1	9.7 (3.3)	8.3 (2.7)
2	9.1 (3.3)	7.3 (2.5)
3	8.7 (3.1)	7.2 (2.6)
4	7.7 (2.9)	7.0 (2.4)
5 (highest IQ)	7.8 (2.8)	6.7 (2.7)
Change in offspring age in 1991 associated with a SD1 increase in parental IQ at age 11		
Change in age	-0.72 (-0.88, -0.56)	-0.52 (-0.70, -0.35)
<i>P value</i>	<i>&lt;0.001</i>	<i>&lt;0.001</i>

Table 3: General health and behaviours in offspring in 1991 according to parental IQ at age 11

Mother-offspring pairs				Father-offspring pairs			<i>P</i> (interaction) <sup>1</sup>
	N (no / yes (%)) <sup>2</sup> N / Mean (SD) <sup>3</sup>	Offspring age and sex adjusted	Multiply adjusted <sup>4</sup>	N (no / yes (%)) <sup>2</sup> N / Mean (SD) <sup>3</sup>	Offspring age and sex adjusted	Multiply adjusted <sup>4</sup>	
Watches 3+ hours of TV on typical week day							
SD increase <sup>5</sup>	788 / 608 (43.6)	0.70 (0.60, 0.82)	0.75 (0.64, 0.88)	465 / 325 (41.1)	0.73 (0.61, 0.87)	0.78 (0.64, 0.95)	<b>0.63</b>
<i>P</i> <sup>6</sup>		<0.001	<0.001		0.001	0.01	
Child has had 2 or more injuries requiring medical attention							
SD increase <sup>5</sup>	1,068 / 375 (26.0)	1.03 (0.90, 1.19)	1.08 (0.93, 1.24)	597 / 225 (27.4)	0.82 (0.69, 0.97)	0.82 (0.69, 0.99)	<b>0.03</b>
<i>P</i> <sup>6</sup>		0.63	0.32		0.02	0.04	
Child has had 1 or more injuries requiring hospitalization							
SD increase <sup>5</sup>	1,279 / 167 (11.5)	0.77 (0.66, 0.90)	0.76 (0.63, 0.90)	724 / 98 (11.9)	0.72 (0.56, 0.91)	0.75 (0.58, 0.96)	<b>0.62</b>
<i>P</i> <sup>6</sup>		0.001	0.002		0.01	0.02	
Child has been admitted to hospital at least once (excluding injuries)							
SD increase <sup>5</sup>	970 / 474 (32.8)	0.91 (0.80, 1.03)	0.92 (0.80, 1.05)	570 / 251 (30.6)	0.93 (0.80, 1.08)	0.92 (0.78, 1.09)	<b>0.62</b>
<i>P</i> <sup>6</sup>		0.13	0.21		0.35	0.35	
Long-standing illness, disability or infirmity							
SD increase <sup>5</sup>	1,168 / 236 (16.8)	1.09 (0.94, 1.27)	1.07 (0.91, 1.26)	682 / 124 (15.4)	0.90 (0.74, 1.11)	0.88 (0.71, 1.09)	<b>0.30</b>
<i>P</i> <sup>6</sup>		0.26	0.40		0.33	0.24	
Height z-score							
SD increase <sup>7</sup>	1,422 / 132.7 (18.5)	0.08 (0.01, 0.14)	0.04 (-0.02, 0.10)	802 / 125.4 (16.4)	0.06 (-0.01, 0.14)	-0.05 (-0.13, 0.02)	<b>0.18</b>
<i>P</i> <sup>6</sup>		0.02	0.20		0.10	0.70	
BMI z-score							
SD increase <sup>7</sup>	1,404 / 17.2 (2.6)	0.03 (-0.03, 0.08)	0.02 (-0.05, 0.08)	798 / 16.8 (2.4)	-0.02 (-0.10, 0.06)	-0.03 (-0.13, 0.06)	<b>0.26</b>
<i>P</i> <sup>6</sup>		0.39	0.62		0.62	0.50	

<sup>1</sup>p for interaction between mother- and father-offspring pairs in models adjusted for offspring age, sex, IQ and parental SES (offspring height associations additionally adjusted for parental height); <sup>2</sup> Binary outcome; <sup>3</sup>Continuous outcome; <sup>4</sup>All associations adjusted for offspring age, sex, IQ, and parental SES (offspring height associations additionally adjusted for parental height); <sup>5</sup>Odds ratio per SD increase in parental IQ; <sup>6</sup>P for linear trend; <sup>7</sup>Mean change per SD increase in parental IQ